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Manipulating the reported age in earliest memories

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ABSTRACT

Previous work suggests that the estimated age in adults' earliest autobiographical memories depends on age information implied by the experimental context [e.g., Kingo, O. S., Bohn, A., & Krøjgaard, P. (2013). Warm-up questions on early childhood memories affect the reported age of earliest memories in late adolescence. *Memory*, 21(2), 280–284. doi:10.1080/09658211.2012.729598] and that the age in decontextualised snippets of memory is younger than in more complete accounts (i.e., event memories [Bruce, D., Wilcox-O'Hearn, L. A., Robinson, J. A., Phillips-Grant, K., Francis, L., & Smith, M. C. (2005). Fragment memories mark the end of childhood amnesia. *Memory & Cognition*, 33(4), 567–576. doi:10.3758/BF03195324]). We examined the malleability of the estimated age in undergraduates' earliest memories and its relation with memory quality. In Study 1 ($n = 141$), vignettes referring to events happening at age 2 rendered earlier reported ages than examples referring to age 6. Exploratory analyses suggested that event memories were more sensitive to the age manipulation than memories representing a single, isolated scene (i.e., snapshots). In Study 2 ($n = 162$), asking self-relevant and public-event knowledge questions about participants' preschool years prior to retrieval yielded comparable average estimated ages. Both types of semantic knowledge questions rendered earlier memories than a no-age control task. Overall, the reported age in snapshots was younger than in event memories. However, age-differences between memory types across conditions were not statistically significant. Together, the results add to the growing literature indicating that the average age in earliest memories is not as fixed as previously thought.

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Infantile or childhood amnesia is the phenomenon that adults have very few to no memories from their first years of life (see for overviews, Bauer, 2014; Pillemer, 1998; Rubin, 2000). Overall, a large body of research suggests that the grand average of the age reported in first memories is 3.5 years across multiple studies (Tustin & Hayne, 2010).

There is some evidence, however, that the age in earliest memories is not carved in stone. To begin with, Wang and Peterson (2014) interviewed children in various age groups (ranging from 4 to 13 years old) about their earliest memory twice, with a delay of 1–2 years between interviews. On the second interview, the same event was, on average, dated 5–7 months later. The results of a subsequent study (Wang & Peterson, 2016) assessing a subgroup of the children 8 years after the initial interview, suggested that the younger children (4–5 years old at baseline) continued to postdate the same memories. The memories were dated as having occurred more than a year later than at initial recall. Thus, dating earliest memories may fall prey to a spontaneous postdating bias (i.e., forward telescoping, Janssen, Chessa, & Murre,

2006). Furthermore, the age in earliest memories may be affected by experimental manipulations. Kingo, Bohn, and Krøjgaard (2013) examined the effects of “warm-up” retrieval. That is, prior to retrieving their very first memory, participants were instructed to recall events from when they were either 3 or 6 years old. This procedure rendered earlier first memories in the age 3 group than in the age 6 group. Likewise, Peterson, Kaasa, and Loftus (2009) found that participants who had overheard confederates talking about very early experiences reported earliest memories in which they were younger than participants who had not been exposed to social influence. In addition, Malinoski and Lynn (1999) reported that at the start of their study, 11% of their participants reported earliest memories from before the age of 2. Yet, at some time during an extensive probing procedure, 78% of the participants reported memories of such a young age.

Together, these results indicate that the age in earliest memories is malleable. This fits with the general notion that dating memories is a reconstructive activity (Friedman, 1993; Janssen et al., 2006). Unlike digital photos, memories do not contain a time-stamp (Arbuthnott & Brown, 2009).

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Sometimes a specific date is part of the factual knowledge (i.e., semantic memory) that is activated together with the recollective re-experiencing (i.e., episodic memory) of a particular event, such as one's wedding day. More often, however, the "when" of a recalled event is inferred from characteristics of the memory representation (e.g., clarity, familiarity, ease of accessibility) or from context information (e.g., the distance of the retrieved event relative to a landmark event; Arbuthnott & Brown, 2009; Janssen et al., 2006). This may of course, easily result in errors (Peterson et al., 2009). Yet, the studies on dating malleability raise the intriguing possibility that earliest memories could be of an earlier age than is generally assumed in the literature on infantile amnesia (Wang & Peterson, 2014, 2016). For example, compared to the grand average of 3.5 years (Tustin & Hayne, 2010), younger average ages were obtained in the experiments reported by Kingo et al. (2013; $M = 2.7$ years in the complete age 3 group) and Peterson et al. (2009; $M = 2.99$ years in the confederate group). Perhaps the age information provided by the study context (e.g., 3 vs. 6 years old) primes participants to search for a memory within a particular life-time period (e.g., "when I was in Kindergarten" vs. "when I was in primary school"). This fits with evidence suggesting that using cues is important for obtaining relatively early memories. Tustin and Hayne (2010) used idiosyncratic timelines displaying photos of the participants at various ages ranging from new-born to current age in an ascending order. Roughly 40% of participating children (up to 12–13 years old) recalled events from before age 2, compared to 4% of adults. Jack and Hayne (2010) found that even adults can come up with memories from under age 2 when a timeline is combined with exhaustive interviewing.

Why would extensive cueing bring about earlier memories than merely asking participants for their earliest memory? The instruction to retrieve an earliest memory likely invites a strategic search in memory (i.e., generative retrieval, Conway, 2005). However, in itself such a general instruction contains few cues, and it is up to the rememberer to generate them. In general, retrieval success depends on the extent to which retrieval cues match some aspect of the memory representation (Tulving & Thomson, 1973). A detailed episodic representation will have a higher probability of being recalled, especially when it is connected to various bits of factual knowledge (i.e., semantic memory), simply because multiple types of cues will match. However, compared to later memories, early memories are impoverished in that they contain fewer narrative categories (e.g., who, where; Bauer & Larkina, 2014; West & Bauer, 1999) and that they have fewer connections with factual knowledge (Howe, 2013; Pillemer, 1998). In addition, factual knowledge may be absent or organised differently in children than adults (Conway, 2005; Howe, 2013), resulting in reduced ways of accessing early representations with further development. Thus, for older children and adults, general "describe-your-earliest-memory" instructions would elicit too few cues

that overlap with too few elements in early representations for retrieval to be successful. Extensive cueing would provide more specific cues matching these sketchy memories (Pillemer, 1998). That does not mean that all early experiences could be accessed if only the right trigger were available. Early, sketchy memories are thought to have a high probability of getting lost because retrieval opportunities are limited due to a lack of narrative organisation (e.g., Bauer, 2014; Bauer & Larkina, 2014).

Nevertheless, some sketchy early memories may survive and turn up in a memory search in adulthood. Mullen (1994) observed that 12–15% of adults' earliest memories retrieved under general instructions were images rather than events. Interestingly, the age in these image memories was younger than in the event memories. Bruce et al. (2005, experiment 2) took this a step further and instructed their participants to report their earliest fragment memories as well as their earliest event memories. Fragment memories were defined as "noncontextualized, stand-alone snippets of the past that are recollections of sensory experiences (images of a visual, auditory, olfactory, or other sensory nature), behaviors or actions, or feelings or emotions" (Bruce et al., 2005, p. 568). An event memory was defined as a story with a beginning and end. The results suggested that earliest fragment memories were of a younger age than earliest event memories. In addition, the memory types differed on a number of dimensions. For example, compared to event memories, fragments were rated as less vivid, less often rehearsed, evoking less intense feelings at the time and rendering less confidence about age estimates (Bruce et al., 2005, experiment 2; Bruce, Phillips-Grant, Wilcox-O'Hearn, Robinson, & Francis, 2007).

The findings regarding memory fragments may have methodological implications for studies on earliest memories. Next to having a lower chance of retrieval due to relatively few appropriate cues, sketchy early memories may not be recognised as memories. That is, characteristics such as vagueness may cause rejection of a fragment as a suitable memory candidate. If so, the fragment will not be reported. Tustin and Hayne (2010) suggested that this may explain their finding that children reported younger earliest memories than adults. Perhaps adults set a higher bar and only report detailed memories, whereas children may accept more sketchy fragments as memories. In line with this, a study instructing adult participants to only report memories that they were certain to remember yielded relatively late memories (i.e., older than age 6 on average; Wells, Morrison, & Conway, 2014).

We present two studies that further examined the malleability of age in earliest memories, taking the possibility that memory fragments are underreported into account. Specifically, prior to instructing participants to retrieve their earliest memory, we explicitly informed them that early memories may be sketchy, and presented them with examples of both fragment and event memories. In this way, we aimed at lowering the bar for reporting

sketchy memories. Study 1 addressed the possibility that including information about age in experimental instructions would affect the average age reported for earliest memories (cf. Kingo et al., 2013; Peterson et al., 2009). The instructions contained vignettes referring to either an early or a late age (around 2 years vs. 6 years). We expected younger average ages in the early than the late condition. In addition, if fragment memories are from an earlier age, we expected to find more fragment memories in the early condition than in the late condition. To briefly preview the results, we found no fragment memories in a strict sense (i.e., disconnected pieces of memory). We had adapted Bruce et al.'s (2005) coding scheme to include snapshot memories, i.e., mental pictures without a temporal sequence. We therefore explored whether the early condition would report more snapshot memories than the late condition. Alternatively, the late age group was expected to report more event memories containing an elaborate, narrative structure. Furthermore, we explored the strategies that people used to date their memory and whether the different instructions would affect age estimates in fragment and event memories differently.

Study 1

Method

Participants

$N = 141$ undergraduate students (34% male) participated in exchange for course credit. Their mean age was 20.4 years ($SD = 1.62$, range 17–28). They were enrolled in an international (English-language) bachelor programme of psychology of a Dutch university. The majority was West-European, i.e., German (75.9%), Dutch (6.4%) or British (2.1%). The remaining 15.6% of the sample had various other backgrounds. The participants were assigned to either an early ($n = 74$) or a late ($n = 67$) condition. Participants in these conditions did not differ with respect to current age, gender and West-European nationality (see Table 1). The study was approved by the departmental ethics committee.

Material

The questionnaire was constructed in English, using Qualtrics software (Version October, 2014) and consisted of the following sections.

Earliest memory and age manipulation. Participants reported their earliest memory after reading three examples of earliest memories (inspired by Peterson et al., 2009) that contained age information. Critically, the early condition read vignettes from around age 2, and the late condition from around age 6. In addition, because in general participants may be unsure whether decontextualised fragments would count as “memories”, we attempted to facilitate the reporting of fragment memories in two ways. First, the examples contained an event memory (i.e., a second vs. a sixth birthday party), a

fragment memory (i.e., taking first steps vs. learning to ride a bicycle) and a description containing characteristics of both memory types (i.e., a fight with a sibling). Second, the actual instructions specifically mentioned the possibility of fragment memories (i.e., lacking continuity, background information and details). Participants were also instructed to report an experience that they could actually remember and not one that they merely knew that had happened to them.

Age estimation, confidence and strategies. After describing their memory, participants estimated their age in the memory by using separate drop-down menus for the year and the month (e.g., 4 years; 6 months). In addition, they indicated how confident they were in both estimates using slider scales ranging from 0 (= *not at all sure*) to 100 (= *100% sure*). Participants indicated how they came up with their age estimates by choosing one of three options (i.e., “I just knew”; “I used a strategy” and “It was a wild guess”). If participants indicated that they just knew or that they used a strategy, they were asked to describe how they arrived at their estimate as detailed as possible.

Memory characteristics. Memory characteristics (adapted from the AMCQ, Boyacioglu & Akfirat, 2015; and Bruce et al., 2005) were assessed with 66 items using 7-point Likert scales (1 = *Totally disagree*–7 = *Totally agree*). Originally, the AMCQ has 63 items distributed over 14 subscales (ranging from 3 to 5 items per subscale). We omitted one item (*I can remember the district in which the event took place*) because it does not apply to the Netherlands. The AMCQ dimensions capture the characteristics probed by Bruce et al. (2005), except for continuity and uniqueness. Therefore, we added two items about the extent to which participants recalled things that took place immediately before and after the reported event (Continuity, Cronbach's $\alpha = .69$) and two items about whether the memory reflected a one-time experience (Cronbach's $\alpha = .81$). Reliability analyses of the AMCQ showed poor alphas for two subscales (Time and Place details, Cronbach's $\alpha = .32$; Emotional Distancing, Cronbach's $\alpha = .17$), so these subscales were not used in the analyses. For the other subscales, alpha's were fair to excellent (Vividness, Cronbach's $\alpha = .84$; Belief in Accuracy, Cronbach's $\alpha = .77$; Sensory Details, Cronbach's $\alpha = .71$; Sharing, Cronbach's $\alpha = .88$; Observer Perspective, Cronbach's $\alpha = .81$; Field Perspective, Cronbach's $\alpha = .84$; Narrative Coherence, Cronbach's $\alpha = .63$; Valence, Cronbach's $\alpha = .96$; Emotional Intensity, Cronbach's $\alpha = .87$; Preoccupation with Emotion, Cronbach's $\alpha = .87$). For two subscales, poor Cronbach's alphas improved after removing one item with low item-total correlations (Accessibility Cronbach's $\alpha = .86$; Recollection Cronbach's $\alpha = .76$).¹ We used these adjusted subscales.

Fragmentation. We constructed two items to measure subjective sense of memory fragmentation. First, we provided descriptions of fragment and event memories. Two slider scales (range 0 = “strongly disagree”–100 = “strongly

Table 1. Demographic variables, belief in memory from age 2 and under, age in earliest memory, memory type and strategies in the early and late conditions in Study 1.

	Condition		Test statistic	Effect Size
	Early (<i>n</i> = 74)	Late (<i>n</i> = 67)		
Current age, years (<i>M</i> , <i>SD</i>)	20.2 (1.34)	20.5 (1.87)	$t(118.6)^a = -1.26$	$d = 0.22$
Female gender (%)	67.6	64.2	$\chi^2(1) = 0.18$	$d = 0.07$
West-European (%) ^b	83.8	85.1	$\chi^2(1) = 0.04$	$d = 0.04$
Age in Memory, months (<i>M</i> , <i>SD</i>)	38.6 (12.7)	47.9 (17.6)	$t(119)^a = -3.55^{**}$	$d = 0.61$
Snapshots (%)	48.6	41.8	$\chi^2(1) = 0.67$	$d = 0.14$
Fragmentation (<i>M</i> , <i>SD</i>)	55.4 (28.2)	52.3 (31.9)	$t(139) = 0.60$	$d = 0.10$
Way of estimating years (%) ^c			$\chi^2(2) = 9.54^{**}$	$V = .26$
Used a strategy	54.1	62.7	$\chi^2(1) = 1.08$	$d = 0.18$
Just knew	13.5	25.4	$\chi^2(1) = 3.19$	$d = 0.30$
Wild guess	32.4	11.9	$\chi^2(1) = 8.42^{**}$	$d = 0.50$
Way of estimating months (%) ^c			$\chi^2(2) = 0.30$	$V = .046$
Used a strategy	21.6	19.4		
Just knew	6.8	9.0		
Wild guess	71.6	71.6		
Confidence				
Years (Median, Inter-quartile range)	64 (55)	74 (43)	$U = 2105$	$d = 0.26$
Months (Median, Inter-quartile range)	11.5 (37)	20 (53)	$U = 2304$	$d = 0.12$
Belief in memory \leq age 2 (%)	36.5	35.8	$\chi^2(1) = 0.01$	$d = 0.01$

^aAdjusted df.^bPercentage of participants with either a Dutch, German or English nationality.^cOnly if the overall test was significant, follow-up comparisons are reported.^{**} $p < .01$.

agree") were used to indicate to which degree a memory was like a fragment and like an event memory with a narrative structure. The event memory rating was coded reversely and the average of both scales was used as an index of fragmentation. The reliability of this measure was good, Cronbach's $\alpha = .82$.

Control questions. Three final questions asked the participants to indicate (1) what they thought the purpose of the study was (open question); (2) whether they filled in the questionnaire truthfully (yes/no) and (3) whether they believed that it is possible that people report memories from age 2 and below (yes/no).

Procedure

The participants were recruited for a study on first memories through an online research participant management system, which directed participants to the online Qualtrics questionnaire after signing up. Participants provided informed consent, as well as their gender, age, language and their month of birth. Because at the time we were unaware of the possibility of random assignment in Qualtrics, birth month was used for allocating participants to either the early or late condition (odd birth months – early condition; even birth months – late condition). This strategy rendered more participants in the early condition, and the final $n = 12$ were allocated to the late condition irrespective of birth month.

Coding

The memories were experimenter-coded based on the participants' verbal descriptions. We adapted Bruce et al.'s (2005) coding scheme, using four categories. A fragment referred to a disconnected piece of memory, lacking all

background information (e.g., a sensory impression). A snapshot was defined as a mental picture without a temporal sequence, but possibly containing some context information (e.g., "My first memory goes back to when I was in my old parent's house, I remember myself in my room, looking at the shelf with my comics on it."). An event memory referred to a description containing a clear temporal sequence ("I am running down the hallway crying, I am sitting down to watch a movie. It is a movie about dinosaurs. My mom comes in the room and asks me why I'm crying. I point at the TV while crying"). A repetitive memory referred to multiple similar events (e.g., "I remember my great granddad buying me cola at the bar in his retirement home every time I went there"). One of the authors (TS) coded all memories. Two raters (TS and IW) coded 57 memories (38%) independently. Inter-rater reliability was good ($\kappa = .87$).

Analyses

Initially, 159 participants² initiated the online questionnaire. The data from 18 participants were discarded: $n = 6$ were non-completers; $n = 4$ indicated that they had not completed the questionnaire truthfully and inspection of the strategy questions revealed that $n = 8$ had asked their parents' help for dating their memory. Thus, the final sample consisted of 141 participants. Inspection of the control questions revealed that no-one guessed the purpose of the study (i.e., manipulating age through instructions).

For the analyses, a single age estimate in months was calculated by multiplying the number of years by 12 and adding the month estimate. Two extreme outliers were assigned a value of 1 unit above the second highest

value (Tabachnick & Fidell, 2007). The same procedure was followed for outliers in the memory characteristic variables (sharing 1 outlier; preoccupation with emotion 1 outlier; continuity 2 outliers). Group differences were examined using analyses of variance (ANOVAs), *t*-tests and, if assumptions were not met, nonparametric Mann–Whitney *U* tests. We used a sequential Bonferroni–Holm procedure in the exploratory ANOVAs to control for family-wise error rates (Cramer et al., 2016).

Results and discussion

Age in the early and late conditions

As can be seen in Table 1, the early condition reported a lower average age in their in earliest memories than the late condition. A *t*-test showed that this difference was statistically significant.

Exploratory analyses

Memory type in the early and late conditions. Regarding memory type, it was unexpected that none of the memories received a fragment coding. In total, 45.4% of the memories were coded as snapshots and three memories were coded as repetitive memories. We incorporated the repetitive memories in the event memory category. A χ^2 test revealed that the percentages of experimenter-coded snapshots did not differ significantly between the conditions. Likewise, the conditions did not differ significantly with respect to self-reported fragmentation. Thus, the evidence for the predictions that the early condition would report more sketchy memories than the late condition was inconclusive at both the objective (experimenter-coded) and subjective (self-report) level.

Strategies and belief in very early memories. We first explored the participants' strategies for arriving at their estimate of the number of years in the age in their earliest memory. An overall χ^2 test showed a statistically significant difference in strategy use between the early and late conditions. As can be seen in Table 1, more participants in the early condition said that they had guessed the number of years. Using a strategy or just knowing the number of years did not statistically differ between the groups. The majority of participants (71.6%) guessed the number of months. The conditions did not differ statistically.

As for confidence in estimates of the number of years and the number of months, nonparametric Mann–Whitney *U* tests showed no statistically significant differences between the early and late conditions.

Next, we explored the possibility that the reported ages were biased by the age information in the vignettes. That is, the participants may have inadvertently reported an age similar to the age in the instructions just because they read it prior to the estimation process and used it as input without actually probing their memory for information about their age. Indeed, Greenberg, Bishara, and Mugayar-Baldocchi (2017) found that asking whether someone's earliest memory was from before or after a

certain age (e.g., 1 or 6 years) influenced reported ages dependent on the age provided in that question. Because such anchoring effects would especially play a role in judgements under uncertainty, we speculated that the effect of the instruction may be particularly pronounced in the participants who said to have guessed their age. In contrast, participants who relied on autobiographical knowledge (e.g., landmark events) in their age estimation might be less susceptible to context effects.

In order to explore this possibility, we concentrated on the strategies for arriving at the number of years in participants' age estimates. Inspection of these strategies suggested that the "I just knew" and "I used a strategy" options did not seem to yield descriptions of qualitatively different strategies. Therefore, we collapsed them into a category expressing the use of autobiographical knowledge for all participants (AK-users, $n = 108$), except for one participant in the late condition. He had chosen the "just knew" option, but answered that he did not know how he knew. This participant and the guessers were coded as non-AK-users ($n = 33$).

Next, we contrasted the age estimates of AK-users and non-AK-users. Testing this difference across the early and late conditions was complicated by the presence of only relatively few ($n = 9$) non-AK-users in the late condition. As widely varying cell sizes would render a 2 (condition: early vs. late) \times 2 (strategy: using vs. not using autobiographical knowledge) ANOVA suboptimal, we limited the comparison of AK-users with non-AK-users to the early condition. In addition, we reasoned that scepticism about the possibility of very early memories (i.e., from age 2 or under) might interfere with a context-induced report bias. The percentages of participants saying that they believed it is possible that people have memories of age 2 and under (see Table 1) did not differ statistically between the early and late conditions, $p = .935$. However, a *t*-test revealed that overall, believers reported significantly younger ages ($M = 38.41$, $SD = 16.80$) than non-believers ($M = 45.63$, $SD = 14.77$), $t(139) = 2.65$, $p = .009$, $d = 0.45$. We therefore controlled for believing in memories from age 2 and under in a subsequent ANOVA comparing AK-users ($n = 50$) and non-AK-users ($n = 24$) users in the early condition.

The ANOVA showed that the non-AK-users ($M = 42.4$ months, $SD = 12.7$) reported to be significantly older in their memory than the AK-users ($M = 36.0$ months, $SD = 12.5$), $F(1, 71) = 4.37$, $p = .04$, $\eta_p^2 = .058$. The means adjusted for belief in memories of age 2 and under in the late condition were 50.8 months ($SD = 17.2$) for the non-AK-users ($n = 9$) and 45.8 months ($SD = 17.7$) for the AK-users ($n = 58$). Thus, the participants who estimated their age based on autobiographical knowledge reported earlier memories than the participants who guessed. This runs counter to the idea that the age information in the vignettes simply biased the reporting of age estimates: in that case we would have expected to see the age effects especially in guessers. Instead, we speculate that the age information in the vignettes primed participants to start

their memory search in a particular life-time period. Of course, the results should be replicated in future studies. An alternative explanation is that the number of data-dependent decisions in our exploratory analyses resulted in inflated type I error, and thus reflects a spurious finding (see Gelman & Loken, 2014).

Age in snapshots and event memories across conditions. We also explored whether the age information affected the age in experimenter-coded snapshots and event memories differentially. Again, we controlled for belief in memories from age 2 or under in a 2 (Condition) \times 2 (Memory Type) ANOVA. The main effect for condition, $F(1, 136) = 11.35$, $p = .001$, $\eta_p^2 = .077$, was statistically significant (adjusted $\alpha = .0167$). This main effect is conceptually similar to the t -test reported earlier, but in this particular ANOVA it shows that age estimates in the early condition were significantly younger than in the late condition even when believing in the possibility of very early memories was controlled for. In addition, a significant (adjusted $\alpha = .025$) main effect for memory type, $F(1, 136) = 11.63$, $p = .001$, $\eta_p^2 = .079$, indicated that age in snapshot memories ($M = 37.6$, $SD = 14.6$) was younger than in event memories ($M = 45.8$, $SD = 14.5$). The condition by memory type interaction effect was statistically significant (adjusted $\alpha = .05$), $F(1, 136) = 5.50$, $p = .02$, $\eta_p^2 = .039$. To follow up on this interaction, we ran an ANOVA controlling for belief in memories age 2 and under with the condition by memory type interaction represented by four different levels (i.e., Early Snapshots; Late Snapshots; Early Event memories and Late Event memories). *Post hoc* Tukey tests suggested that especially event memories in the late condition differed from their counterparts in the early condition, mean difference = -13.82 , $SE = 3.23$, $p < .001$, and from snapshot memories in both the late (mean difference = -13.85 , $SE = 3.51$, $p = .001$) and early (mean difference = -16.33 , $SE = 3.28$, $p < .001$) conditions. All other comparisons did not reveal significant differences, all p 's $> .872$. Together, the finding that snapshots are from a younger age than event memories extend Bruce et al.'s (2005) findings on fragment memories. Moreover, the snapshot memories seemed relatively insensitive to the age manipulation.

Characteristics of snapshot and event memories. We also explored whether the phenomenological differences between fragment and event memories (Bruce et al., 2005) would extend to snapshot memories. Table 2 presents the characteristics for snapshots and event memories separately. It should be noted that the three repetitive memories were excluded from the analyses. Compared to earlier findings that fragments and event memories differed on many dimensions (Bruce et al., 2005), there were only a few statistically significant differences between the present memory types. Snapshot memories were rated as less often shared and more fragmented than event memories. The latter indicates that the experimenter-coded snapshot – event memory distinction matched the participants' subjective experience.

Table 2. Mean ratings of age in and characteristics of snapshots and event memories in Study 1.

	Memory type		t (136)	Cohen's d
	Snapshot ($n = 64$)	Event ($n = 74$)		
Vividness	3.81 (1.24)	4.05 (1.18)	–1.18	0.20
Belief in accuracy	4.26 (0.96)	4.60 (1.11)	–1.89	0.33
Accessibility	3.98 (1.74)	4.23 (1.73)	–0.83	0.14
Recollection	3.48 (1.16)	3.48 (1.27)	0.04	0
Sensory detail	3.59 (1.15)	3.55 (1.25)	0.19	–0.03
Sharing	3.01 (1.31)	3.73 (1.47)	–3.05 ^a	0.52
Narrative coherence	4.15 (1.06)	4.51 (1.01)	–2.03	0.35
Observer perspective	4.03 (1.51)	3.73 (1.48)	1.18	–0.20
Field perspective	4.12 (1.54)	4.60 (1.47)	–1.85	0.32
Valence	5.37 (1.61)	4.79 (1.77)	1.99	–0.34
Emotional intensity	3.41 (1.06)	3.50 (1.31)	–0.46	0.08
Preoccupation with emotion	2.17 (0.95)	2.28 (1.10)	–0.65	0.11
Unique event	4.81 (1.74)	5.53 (1.75)	–2.45	0.41
Continuity	2.03 (1.08)	2.35 (1.25)	–1.61	0.27
Fragmentation	65.8 (27.6)	43.04 (28.3)	4.78 ^b	–0.81

Note: Standard deviations are within parentheses.

^a $p = .003$, adjusted $\alpha = .0036$.

^b $p < .001$, adjusted $\alpha = .0033$.

Study 2

The results of Study 1 suggest that using a particular age in instructions for retrieving a first autobiographical memory may influence the subsequent estimate of the age in that memory. Study 2 further built upon the idea that the age information in the vignettes functions as a starting point for a deliberate search through an autobiographical knowledge base.

According to the self-memory system model of autobiographical memory (e.g., Conway, 2005; Conway & Pleydell-Pearce, 2000), autobiographical knowledge is hierarchically organised with layers running from general to specific information. An important organising principle for the more abstract layers is that of thematic life-time periods (e.g., “when I was in elementary school”). People may use a life-time period as a first entry for self-generating cues in an iterative search for a specific memory (cf. Conway, 2005). Age information referring to different life-time periods (e.g., “preschool” vs. “elementary school”) may thus render different starting points. This first cue may be elaborated on by activating bits of self-knowledge from that particular life-time period (“Where did we live?”).

In Study 2 we specifically examined whether activating self-related semantic knowledge from an early life-time period (i.e., the preschool years) affects the estimated age in earliest memories. There were three conditions. In the self-relevant knowledge condition participants answered questions about personal facts from their preschool period (e.g., the brand of the family car). To examine whether thinking back on a particular age-period is sufficient for affecting age estimates, a public-event knowledge condition asked about news events that occurred during the participants' preschool years (e.g., the fall of the Berlin wall). In the third condition, we

just asked for participants' very first memory without age information. Study 1 lacked such a control and thus it is unknown whether the age-differences were due to the early instructions facilitating lower age estimates, or to the late instructions increasing them.

There were a number of additional methodological improvements compared to Study 1. To begin with, to prevent participants from using external information (e.g., asking parents) to generate age estimates, they were tested in the laboratory rather than online. In addition, not a single memory in Study 1 was coded as a fragment memory. Perhaps the instructions aiming at lowering the criterion for what counts as a memory had been too implicit. In Study 2 we explicitly defined fragment and event memories and clarified how they differed. Finally, we used a briefer measure of autobiographical memory characteristics in Study 2 (i.e., MCQ; Schaefer & Philippot, 2005) because anecdotal reports suggested that participants in Study 1 found the AMCQ (Boyacioglu & Akfirat, 2015) long and tedious.

In sum, Study 2 sought to replicate and extend the findings of Study 1 that the age in earliest memories is malleable. If the activation of self-relevant knowledge plays a critical role, we expected to find younger ages in earliest memories in the self-relevant knowledge condition than in the public-event knowledge and no-age conditions. Alternatively, if just thinking about a particular life-time period is sufficient for generating earlier memories, then the age estimates in the self-relevant and public-knowledge conditions should be younger than in the no-age controls. Additionally, we aimed at replicating the finding that especially snapshot (and fragment) memories are relatively insensitive to an age manipulation.

Method

Participants

Participants were 162 students (25.3% male) with a mean age of 21.65 years (range 18–25 years). The majority of the participants had a West-European nationality and were either German (42%), Dutch (27.2%) or British (1.9%). Twenty-nine per cent had various other cultural backgrounds. Participants were randomly assigned to a self-related knowledge ($n = 53$), a public-event knowledge ($n = 55$) or a control condition ($n = 54$). Participants in these conditions did not differ with respect to current age, gender and West-European nationality (see Table 3). The participants were reimbursed with either course credit ($n = 4$) or 5 Euros ($n = 158$). The study was approved by the departmental ethics committee.

Material and procedure

Participants were recruited through advertisements on a local Facebook group for paid research participants ($n = 115$) and the departmental online research participant management system ($n = 47$). For practical reasons related to the construction of the public-event questions, we only included participants between the ages of 18

and 25. Groups with a maximum of three participants were tested in the laboratory. Each participant was randomly allocated to one of three conditions. After signing informed consent, participants completed their digital questionnaires individually at separate desktop computers.

The questionnaire was constructed in Qualtrics (Version April, 2015). Following demographic information, it included the following sections.

Knowledge and age manipulation. There were 24 yes/no questions. The nature of these questions depended on condition. In two conditions the questions concerned knowledge related to the participants' first three years of life. Participants were informed that ages 0–3 would be referred to as their pre-kindergarten (or preschool for Dutch participants) years. In the *Self-related knowledge (SRK) condition*, the questions asked for facts from participants' lives during that time (e.g., whether they knew the brand of the family car; whether there was a pet in their household). In the *Public-event knowledge (PEK) condition*, the questions asked whether particular public events had occurred during the participants' first three years of life (e.g., the fall of the Berlin wall; the introduction of the Euro as European currency). To avoid response tendencies, 50% of the questions were tailored to the years matching each participant's preschool age (yielding a potential "yes" response), whereas 50% of questions referred to the three years *before* the participant was born (yielding a potential "no"). Thus, for a participant who was 18 years old at the time of the study (2015) half of the questions were about events that had happened in 1997–1999, whereas the other half reflected events from the years 1994–1996. In the *Control condition*, participants solved 24 arithmetical problems (e.g., "Is $(3 \times 2) + 1 = 6$?" taken from the Operation Span task (Conway et al., 2005). Participants indicated whether the suggested outcome was correct (Yes/No). Half of the solutions provided were correct, the other half was incorrect.

The remainder of the questionnaire was the same in all three conditions.

Earliest memory. Participants reported their earliest memory along the lines of the instructions in Study 1, but the vignettes in Study 2 contained one situation (the birthday party) that was described as both an event and a fragment memory. In addition, the differences between fragment and event memories were described, explicitly referring to the vignettes. Furthermore, participants were instructed to report an "experience that you can actually remember and not one that you merely know from narrations, photographs or videos for instance".

Age estimation, confidence and strategies. The questions about age estimates and confidence ratings were identical to Study 1. The strategy questions now contained two options (i.e., "It was a wild guess" and "I used a strategy"). In addition, participants were asked whether there were videos or photographs of the reported memory. Answers included one "no" option and three "yes" options (i.e., *the same specific scene*; *the same event but not the same scene*; *the same scene but not the same perspective*).

Table 3. Demographic variables, memory type and control variables in the self-relevant knowledge, public-event knowledge and control conditions in Study 2.

	Condition			Test statistic, DF	Effect size
	SRK (<i>n</i> = 53)	PEK (<i>n</i> = 55)	Control (<i>n</i> = 54)		
Current age in years (<i>M</i> , <i>SD</i>)	21.9 (1.80)	21.2 (1.66)	21.9 (1.60)	$F(2, 159) = 2.57$	$\eta_p^2 = .031$
Female gender (%)	77.4	74.5	72.2	$\chi^2(2) = 0.37$	$V = .048$
West-European (%) ^a	73.6	74.5	64.8	$\chi^2(2) = 1.51$	$V = .097$
Age in memory, months (<i>M</i> , <i>SD</i>)	38.2 (13.3)	37.2 (10.9)	45.7 (17.5)	$F(2, 159) = 5.83^{**}$	$\eta_p^2 = .068$
Snapshots (%) ^b	45.3	47.3	46.3	$\chi^2(2) = 0.04$	$d = .016$
Fragmentation (<i>M</i> , <i>SD</i>)	60.4 (34.5)	68.1 (29.7)	59.84 (32.6)	$F(2, 159) = 1.12$	$\eta_p^2 = .014$
Used AK (%)					
Year estimate	77.4	69.1	75.9	$\chi^2(2) = 1.11$	$d = .083$
Month estimate	28.3	38.2	38.9	$\chi^2(2) = 1.64$	$d = .101$
Confidence					
Years (Median, Inter-quartile range)	71 (41)	70 (45)	75 (30)	$\chi^2(2) = 0.18$	$\eta_{k-w}^2 = .001$
Months (Median, Inter-quartile range)	26 (88)	25 (63)	25 (71)	$\chi^2(2) = 0.29$	$\eta_{k-w}^2 = .002$
Photos of the event (%)	24.5	27.3	20.4	$\chi^2(2) = 0.72$	$V = .067$
Belief in memory \leq age 2 (%)	49.1	38.2	44.4	$\chi^2(2) = 1.31$	$V = .090$

Notes: SRK = self-relevant knowledge; PEK = public-event knowledge and IQR = inter-quartile range.

^aPercentage of participants with either a Dutch, German or English nationality.

^bIncludes four fragments.

Autobiographical memory characteristics

Memory Characteristics Questionnaire (MCQ). Different from Study 1, we used Schaefer and Philippot's (2005) version of the MCQ. It consists of 20 items asking for characteristics on different dimensions: (1) "Clarity" (6 items; Cronbach's $\alpha = .81$)³ representing general vividness of the memory depending on perceptual and sensory information; (2) "Sensory details" (4 items; Cronbach's $\alpha = .57$) reflecting sound, smell, touch and taste; (3) "Time" (5 items; Cronbach's $\alpha = .67$) addresses the memories' time context as year, season, day and hour; (4) "Spatial context" (3 items; Cronbach's $\alpha = .67$) represents the location and spatial arrangements of their memory; and (5) "Thoughts and Feelings" (2 items; Cronbach's $\alpha = .72$) the memory for what they thought and felt at the time. We added 10 items that were used by Bruce et al. (2005, 2007), asking for the extent to which participants recalled events before and after the event in their earliest memory (Continuity, 2 items, see Study 1; Cronbach's $\alpha = .58$); valence ("The overall tone of the memory is negative/positive", "My feelings at the time were negative/positive"; Cronbach's $\alpha = .95$); emotional intensity (1 item); vantage perspective (1 item); talking about the event (sharing, 1 item); thinking about it (rehearsal, 1 item); whether the setting was familiar (1 item) and whether the event seemed long (duration, 1 item). Each of the 30 items was rated using a 100-point slider scale.

Centrality. The short version of the Centrality of Event Scale (CES; Berntsen & Rubin, 2006) assessed how central the event in the earliest memory was to a person's identity and life story. The CES contains 7 items, rated on a 5-point Likert scale (1 = *totally disagree*–5 = *totally agree*). The total score ranges between 7 and 35 with higher scores indicating higher centrality. Internal consistency in the current sample was good (Cronbach's $\alpha = .88$).

Fragmentation. We used the same measure of fragmentation as in Study 1. The internal consistency was excellent (Cronbach's $\alpha = .93$).

Control questions. The same control questions as in Study 1 were used.⁴

Coding

The memories were coded following the criteria of Study 1 by two independent raters (TS and a research assistant) who were blind to condition. Their inter-rater reliability was high, $\kappa = .85$. Differences were resolved by discussion.

Analyses

Initially, 166 participants participated in the study. Inspection of the strategies revealed that four participants had learned the age in their memory from a family member on an earlier occasion. The data from these participants were discarded, leaving a final sample of $n = 162$. None of the participants guessed the purpose of the study (i.e., manipulating age estimates) and all said to have responded truthfully. The data-analytic strategies were similar to Study 1. The age estimate variable was adjusted as follows. Three extreme outliers were assigned a value of 1 unit above the second highest value and two outliers were given a value of 1 unit below the second lowest value of their condition (Tabachnick & Fidell, 2007). It should be noted that the latter two adjusted values concerned participants who said that they remembered their own birth and being 3 months old in their memory. Other variables that were adjusted for outliers in a similar way were the CES (three outliers); MCQ clarity (three outliers); Valence (four outliers); Event duration (five outliers) and Fragmentation (two outliers).

Results and discussion

Age and memory type across conditions

As can be seen in Table 3, a one-way ANOVA rendered a significant difference between the conditions regarding the age in earliest memories. *Post hoc* Tukey tests indicated that compared to the control condition, both the SRK

(mean difference = 7.46, SE = 2.43) and the PEK (mean difference = 8.52, SE = 2.41) reported significantly younger ages. The SRK and PEK conditions did not differ significantly from each other. Thus, having participants think about an early life-time period (i.e., their preschool years) was sufficient to affect the age in their earliest memories. These results suggest that activating self-relevant knowledge is not crucial to elicit younger ages.

Overall six memories (3.7%) were coded as repetitive and four memories (2.5%) were fragments. Because of their low frequency, repetitive memories were incorporated in the event memory category and fragments were included in the snapshot memory category. The conditions did not differ significantly with respect to the number of experimenter-coded snapshot memories. Likewise, there were no significant differences with regard to self-reported fragmentation. Thus, in line with findings in the early condition in Study 1, participants reported younger ages in the conditions that referred to an early life-time period but the evidence that their memories were sketchier than those in controls was inconclusive.

Confidence, pictures, belief in memories from age 2 and under, and strategies

Table 3 also shows that there were no significant differences between the conditions regarding participants' confidence in their age estimates. In addition, 24.1% of the sample said that there were pictures or videos that were associated with their memories. Because of the relatively low number of participants that endorsed the various "yes" items (i.e., 6.8% same specific scene; 9.3% same event but other scene; 8% same event but other perspective), these percentages were collapsed into one "yes" category. The percentage of endorsers did not differ significantly between conditions. On average, the age in earliest memories did not significantly differ between participants who had photos or videos corresponding to the memory ($M = 42.0$, $SD = 15.8$) and those who did not ($M = 39.8$, $SD = 14.2$), $t(160) = -0.82$, $p = .412$, $d = 0.15$. Furthermore, the percentage of participants who believed that it is possible that people have memories of age 2 or under did not differ significantly across conditions. However, participants who said that they believed in the possibility of having memories from age 2 or under estimated their age as significantly younger ($M = 33.8$, $SD = 13.1$) in their memories than participants who did not ($M = 45.5$, $SD = 13.6$), $t(160) = 5.52$, $p < .001$, $d = -0.87$.

Similar to Study 1, we explored whether the use of autobiographical knowledge rendered different age estimates across condition. It can be seen in Table 3 that the percentages of AK-users did not differ significantly between conditions. A 2 (AK-use) \times 3 (Condition) ANOVA controlling for belief in early memories showed no significant main effect of AK-use, $F(1, 155) = 0.06$, $p = .807$, $\eta_p^2 < .001$. Likewise, there was no significant AK-use by condition interaction, $F(1, 155) = 0.954$, $p = .387$, $\eta_p^2 = .012$. For AK-users, the ages were $M = 37.2$, ($SD = 2.02$); $M = 36.8$, ($SD = 2.13$) and

$M = 45.7$ ($SD = 2.02$) for the SRK, PEK and Control conditions, respectively. For the non-AK-users, the ages were $M = 41.3$, ($SD = 3.73$) for SRK, $M = 33.6$ ($SD = 3.13$) for PRK and $M = 43.0$ ($SD = 3.60$) for controls.

Age in snapshots and event memories across conditions

Next, we checked whether the finding in Study 1 that the age in snapshots and event memories differed across conditions would also be evident in Study 2. As belief in memories from age 2 or under affected age estimates, we controlled for this variable in a 3 (Condition) \times 2 (Memory Type) ANOVA. The main effect for Condition, $F(2, 155) = 7.49$, $p = .001$, $\eta_p^2 = 0.09$, was statistically significant (adjusted $\alpha = .0167$). Thus, the difference between the conditions remained statistically significant after controlling for belief in very early memories. The main effect of memory type, $F(1, 155) = 9.17$, $p = .003$, $\eta_p^2 = .056$, was also significant (adjusted $\alpha = .025$). Overall, participants reported to be younger in snapshot ($M = 36.4$, $SD = 12.6$) than in event memories ($M = 42.5$, $SD = 12.7$). The condition by memory type interaction $F(2, 155) = 0.85$, $p = .430$, $\eta_p^2 = .011$, was not statistically significant (adjusted $\alpha = .05$). Thus, the finding in Study 1 that especially event memories were sensitive to the age manipulation was not replicated.

Characteristics of snapshot and event memories

Table 4 displays the subjective ratings of the phenomenological characteristics of snapshots and event memories. Repetitive memories were excluded from the analyses. Three out of 15 comparisons were significant after sequential Bonferroni correction. Snapshots were rated as containing poorer recall of what happened before and after, as more fragmented and as more positive than event memories.

General discussion

We report on two studies examining whether age information implied by the experimental context influences the reported age in participant's earliest memories. In Study 1 participants were presented with vignettes describing earliest memories that explicitly mentioned a specific age that was either early (1–2 years old) or late (5–6 years old). On average, participants in the early condition reported to be significantly younger in their first memories than participants in the late condition. Study 2 examined whether activating self-relevant knowledge from the preschool years is important for decreasing the age in earliest memories. Thinking about self-relevant information from this earliest life-time period indeed resulted in younger average ages than in a no-age control group. However, thinking about public events from this life-time period also rendered earlier ages. The age estimates in the public-event knowledge and self-relevant knowledge conditions did not differ in a statistically

Table 4. Mean or median ratings of age in and characteristics of snapshots and event memories in Study 2.

	Memory type		Test statistic	Cohen's <i>d</i>
	Snapshot (<i>n</i> = 75)	Event (<i>n</i> = 81)		
Event centrality (<i>M</i> , <i>SD</i>)	12.5 (4.78)	13.2 (5.52)	$t(154) = -0.90$	0.15
MCQ				
Clarity (<i>M</i> , <i>SD</i>)	59.1 (18.7)	63.23 (14.9)	$t(154) = -1.53$	0.24
Sensory Detail (Median, Interquartile range)	15 (32)	22.8 (21)	$U = 2382$	0.38
Time (<i>M</i> , <i>SD</i>)	33.7 (20.8)	36.0 (20.1)	$t(154) = -0.69$	0.11
Context (<i>M</i> , <i>SD</i>)	64.4 (22.0)	65.0 (21.8)	$t(154) = -0.18$	0.03
Thoughts & feelings (<i>M</i> , <i>SD</i>)	42.9 (29.3)	51.5 (24.9)	$t(154) = -1.98$	0.32
Field perspective (Median, Interquartile range)	84 (50)	74 (46)	$U = 2767$	0.15
Emotion				
Valence (<i>M</i> , <i>SD</i>)	77.4 (23.4)	53.3 (31.0)	$t(154) = 5.51^a$	-0.87
Intensity (<i>M</i> , <i>SD</i>)	57.9 (25.6)	61.3 (24.6)	$t(154) = -0.85$	0.14
Thought about it (<i>M</i> , <i>SD</i>)	45.8 (24.2)	47.7 (28.0)	$t(154) = -0.47$	0.07
Talked about it (Median, Interquartile range)	19 (42)	20 (42)	$U = 2984$	0.03
Event duration (<i>M</i> , <i>SD</i>)	29.5 (24.6)	34.3 (23.8)	$t(154) = -1.23$	0.20
Setting unfamiliar (Median, Interquartile range)	20 (49)	18 (31)	$U = 2789$	0.14
Continuity (Med, IQR)	1.50 (14.5)	24.5 (38)	$U = 1703^b$	0.82
Fragmentation (<i>M</i> , <i>SD</i>)	72.1 (30.1)	55.2 (32.7)	$t(154) = 3.35^c$	-0.81

Notes: Standard deviations or inter-quartile ranges are within parentheses.

^a $p < .001$, adjusted $\alpha = .0033$.

^b $p < .001$, adjusted $\alpha = .0036$.

^c $p = .001$, adjusted $\alpha = .0038$.

significant fashion. Thus, it seems that in itself, thinking about an early life-time period results in reporting earlier ages and that the type of information that is thought about is not particularly important.

In both studies the average ages in the conditions referring to an early life-time period were a little over 3 years old. At first sight this is younger than the grand average of 3.5 years in the literature (Tustin & Hayne, 2010). As Study 1 lacked a control condition that was silent about age, it is unknown whether the early instructions in Study 1 facilitated lower age estimates, or whether the late instructions increased them. The difference between the knowledge conditions and the no-age control condition in Study 2, however, suggests that the age in earliest memories can indeed be reliably decreased. This fits with earlier findings that participants reported earlier ages after manipulations introducing relatively young ages (Kingo et al., 2013; Peterson et al., 2009). The ages reported in these earlier studies were even slightly younger (i.e., about 32 months in the early condition in Kingo et al., 2013; 36 months in Peterson et al., 2009) than in our studies (i.e., between 37.2 and 38.6 months). This may have to do with the manner of asking the questions. In the previous studies participants just wrote down their age, whereas we asked for separate estimates of the number of years and months. Perhaps people are less inclined to write down the number of months spontaneously. Asking for the number of months on top of the number of years would then results in slightly older ages.

We also expected that the manipulations bringing down the age in earliest memories would yield more sketchy memories, in line with earlier work reporting that fragments are younger than event memories (Bruce et al., 2005). Contrary to expectations both studies yielded few

fragment memories. In addition, the percentages of snapshot memories (i.e., isolated images) did not differ significantly between conditions. Yet, reminiscent of earlier findings in fragment memories (Bruce et al., 2005), both studies showed that irrespective of condition, snapshot memories were of a younger age than event memories. Moreover, the results of Study 1 suggested that the difference between the early and late condition was most prominent for the event memories. The age estimates of snapshots seemed to be less sensitive to the age manipulation. However, this pattern of results was not replicated in Study 2.

The present studies explored two types of explanations for observations that the average age in earliest memories is malleable. In Study 1, the possibility that age estimates reflect a context-induced report bias was explored. The idea was that once a childhood memory has been retrieved, people use the externally provided age information as an anchor for estimating their age in that memory (Greenberg et al., 2017). Usually people use highly salient experiences with a known age (i.e., landmark experiences, e.g., one's first day at school) as a reference point for estimating their age in autobiographical memories (Arbuthnott & Brown, 2009). This should inoculate age estimations against context effects. Thus, if indeed the age in the instructions were echoed in participants' age estimates, this should be especially apparent in people guessing their age. In the absence of autobiographical knowledge people might (inadvertently) use contextual information in their answers. However, Study 1 showed the opposite pattern: guessers in the early condition were *older* in their earliest memory than participants who had used autobiographical knowledge. This renders an explanation in terms of a context-induced report bias

less likely. Yet, this interpretation is based on exploratory analyses that should be replicated independently. An explanation in terms of priming or anchoring cannot be excluded at this point and future studies may further shed light on this issue.

The second type of explanation for the malleability of age in earliest memories is that the search process is influenced by the age information in the experimental context. That is, participants may use the life-time period referred to as a starting point for a deliberate memory search. It is thought that in order to navigate the search, the process involves iterations of self-generating cues (e.g., Conway, 2005). Starting within a particular life-time period would increase the probability that these self-generated cues represent knowledge that is specific to that life-time period. This, in turn, would increase the probability of retrieving a memory from that particular life-time period. Study 2 examined whether self-related knowledge questions about an early life-time period would aid the search process and result in younger ages. The lack of difference between the self-related and public-event-related knowledge conditions suggests that focussing on personal knowledge is not crucial for generating earlier memories than when no life-time period at all is used. In itself, thinking about an early period in life seems to be sufficient to render memories of younger ages. Perhaps the public-event questions provided participants with an anchor point to start their search, after which they turned to self-generating cues relying on knowledge from that life-time period to an equal extent as the participants in the self-relevant knowledge condition. It seems that the notion that age information in the experimental context provides a starting point for a memory search suffices to explain age-differences in earliest memories in the present studies. Future studies may examine this explanation further. Future work may also compare the impact of using vignettes (Study 1) and activating life-time period knowledge (Study 2) directly.

It has been suggested that sketchy memories are indicative of a developmentally earlier stage (Bruce et al., 2005; Conway, 2005; Pillemer, 1998). However, we did not find that the early conditions in our studies rendered more fragment memories than late or control conditions. In fact, we obtained very few fragment memories according to the rather strict criterion that they should represent decontextualised snippets of previous experience (cf. Bruce et al., 2005). Instead, we found that just under half of the memories fitted a category that we termed snapshot memories, reflecting scenes that did have some context but lacked temporal order. The percentages of snapshot memories were fairly consistent across conditions and studies (i.e., ranging from 41.8% to 48.6%) and they were consistently of a younger age than event memories across conditions. A comparison of phenomenological characteristics yielded only a few meaningful differences between snapshots and events. In both studies snapshots were more fragmented than events. In Study 1, events were shared

more often and in Study 2 they contained more continuity and were less positive than snapshots. However, Bruce et al. (2005) reported that fragments and event memories differed in many more aspects and this suggests that snapshots may qualitatively differ from fragments. It should be noted that a number of the characteristics (recalling what happened before and after; fragmentation) are implied by the definition of snapshots and event memories and differences would thus reflect our coding scheme. However, these definitions are silent about emotional valence. It is interesting that snapshots were rated as more positive than event memories as the findings regarding emotional valence in the broader literature on childhood amnesia have been mixed (West & Bauer, 1999). To inform theory, future studies may further explore the usefulness of a distinction between fragments and snapshots. In addition, future work may follow up on the finding in Study 1 that snapshots seemed to be less sensitive to the age manipulation.

There are some methodological considerations that deserve attention. For example, it may be that in general, participants do not consider fragment memories as memories because of their characteristics such as vagueness (Tustin & Hayne, 2010). In spite of our attempts to lower the criterion for accepting mental representations as memories we obtained only a few fragment memories. It should be noted that in Bruce et al.'s studies, participants were explicitly instructed to retrieve fragment memories, whereas we coded memory type in a *post hoc* fashion. Thus, the very low number of fragments obtained in the present studies may indicate that participants did not readily retrieve fragments spontaneously. Future studies may use explicit instructions to retrieve fragments. In addition, our criteria for coding fragments may have been more stringent than in Bruce et al.'s (2005, 2007) studies. More generally, a distinction between categories of fragment and snapshots may be rather arbitrary. Future work may rely on scoring on a continuum running from "fragment" to "event" as this might more closely reflect the richness of the participants' memory reports. Furthermore, we used different measures of autobiographical memory characteristics in Studies 1 and 2, rendering the results less comparable. Future studies may optimise the assessment of characteristics.

A further consideration is that our samples mainly consisted of Western participants. There is evidence that cultural background matters (see Mullen, 1994; Wang, 2014). On average, participants from Eastern cultures report later earliest memories than those from Western cultures. A minority of our samples (i.e., 16% in Study 1 and 29% in Study 2) indicated that their nationality as other than German, Dutch or English. It is unknown how many had an Eastern cultural background as we did not ask them to specify. Nationality is unlikely to be responsible for the present findings as it did not statistically differ between the conditions in either study. However, our findings cannot be generalised to other cultures. Future work may

determine whether age estimates in early memories are malleable in Eastern cultures as well.

Finally, the finding that asking about public-event knowledge and self-relevant knowledge had a similar effect on age estimates seems to be at odds with findings that extensive cueing renders earlier memories (Jack & Hayne, 2010). However, our self-relevant questions may have been too generic to provide an advantage over a natural tendency to self-generate cues based on autobiographical knowledge. Cues are effective to the extent that they overlap with aspects of the representation in memory (Tulving & Thomson, 1973). It is thought that this specificity is especially prominent in infancy, and that with progressing development the power to reactivate memories generalises to more abstract cues (such as verbal reminders, Imuta, Scarf, & Hayne, 2013). Future studies may use more extensive idiosyncratic questions to see if activating self-knowledge yields earlier (sketchy) memories than questions about public events from an early life-time period.

Taken together, the results of the present studies show that on average, age information introduced by the experimental context affects subsequent estimates of the age in earliest memories. Perhaps this information is used as a starting point for initiating a memory search of a particular life-time period. In addition, the age in snapshot memories was younger than in event memories. The results of Study 1 suggest that snapshots might even be resistant to age manipulations, yet this was not confirmed in Study 2. Future studies may further explore the phenomenological properties of snapshot memories, including the estimates of the age in those memories. Overall, the results of the present studies add to the growing literature that the age in earliest memories is malleable.

Notes

1. These items were "I do not recall this event very often" for the subscale Accessibility and "As I think about the event, I actually remember it rather than just knowing that it happened" for the subscale Recollection.
2. There were 160 cases, but 1 participant started the questionnaire twice. Her incomplete record was discarded.
3. The Cronbach's alphas pertain to the current sample.
4. For exploratory purposes, the questionnaire concluded with the Beck's Depression Inventory-II (Beck, Steer, Ball, & Ranieri, 1996) and a question about the overall affective tone of participants' childhood ("All in all, I would describe my childhood as ...") using a slider scale ranging from 0 (*Negative*) to 100 (*Positive*). There were no differences between conditions, and there were no correlations between these measures and any of the other variables in Study 2. In the interest of space, we refrain from reporting these findings in detail. Information can be obtained from the first author.

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Disclosure statement

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